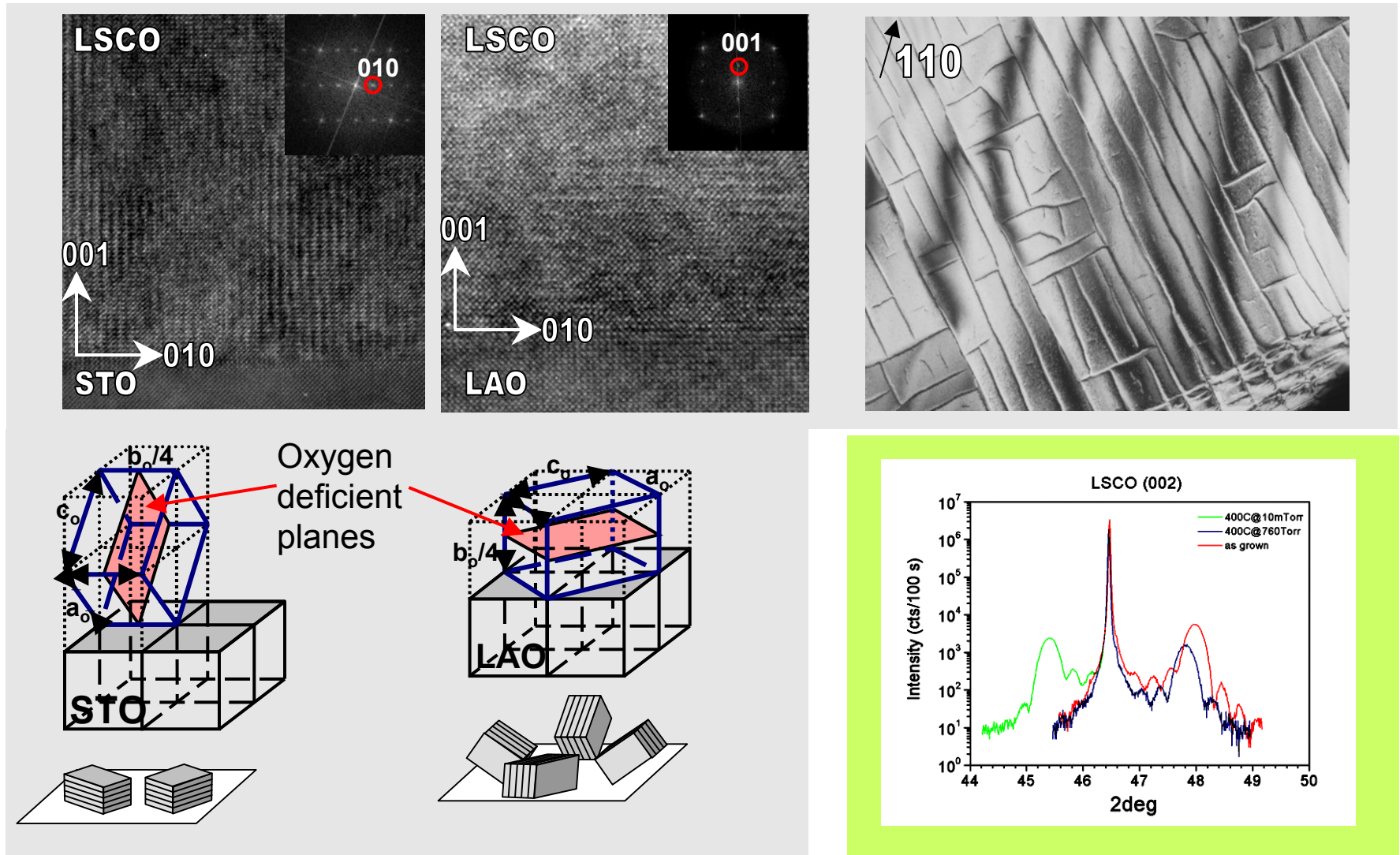


# Interface Science of Functional Perovskites

Susanne Stemmer, University of California, Santa Barbara

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- Oxides with the perovskite structure exhibit an exceptional broad range of electronic properties, such as electrical conductivities that range from superconducting to metallic to insulating, and properties such as colossal magnetoresistance. Interfaces play a key role in determining materials properties. Thin epitaxial films of perovskites are used to obtain controlled orientations and interfaces. The model perovskite,  $\text{La}_{0.5}\text{Sr}_{0.5}\text{CoO}_{3-x}$  (LSCO), investigated in this study, shows metallic conductivity at high oxygen concentrations ( $x = 0$ ). With increasing  $x$  (oxygen deficiency), the electrical resistivity and the conductivity for oxygen increases. The green panel shows that the epitaxial LSCO film exchanges oxygen reversibly with the annealing atmosphere at temperatures below 400 °C. At low oxygen pressures, the film loses oxygen and the lattice parameter expands (green scan). At high oxygen pressures, the film takes up oxygen and the lattice contracts (x-ray diffraction by *W. Donner, University of Houston*). The red panel shows irreversible changes in the microstructure of the films annealed at higher temperatures (500 °C). Films were grown on different substrates:  $\text{SrTiO}_3$  (STO, left) and  $\text{LaAlO}_3$  (LAO, right). The films lose oxygen irreversibly, and new, oxygen vacancy ordered structure form, in which oxygen is missing in alternate planes. The oxygen vacancy ordered structures form different arrangements on the two substrates to minimize the stress due to the lattice mismatch with each substrate, representing a new mechanism of stress relief in thin films [1]. In addition, line defects (dislocations) are introduced (top row, right). These dislocations glide into the films at high temperatures, and make the transformation to the vacancy ordered structure irreversible even if films are subsequently annealed at higher oxygen pressures. The oxygen vacancy ordered structures and the high degree of oxygen deficiency are epitaxially stabilized: bulk LSCO would not become as oxygen deficient at comparable annealing temperatures and oxygen pressures. Different vacancy ordered structures on different substrates may allow new anisotropic oxygen and magnetotransport properties.
- [1] D. O. Klenov, W. Donner, B. Foran, S. Stemmer, *Impact of stress on oxygen vacancy ordering in epitaxial  $(\text{La}_{0.5}\text{Sr}_{0.5})\text{CoO}_{3-\delta}$  thin films*, Applied Physics Letters **82** 3427-3429 (2003).

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## Education:

Two undergraduate students, Brietta Oakley and Ryan P. Haggerty were/are involved in the research. Ryan Haggerty is a UCSB undergraduate student jointly advised by Professors Stemmer and Seshadri (also at the Materials Department, UCSB) and is synthesizing bulk  $\text{La}_{0.5}\text{Sr}_{0.5}\text{CoO}_{3-x}$  with controlled oxygen deficiencies.

## Outreach:

Professor Stemmer presented several talks on novel oxide thin films in outreach symposia organized by the UCSB MRL. During the summer of 2003 she presented to researchers from Mexico (UC-Mexus program) and to high school and undergraduate student summer interns in the RISE program.